Summary of Additional Modeling for Entergy Independence

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Background

On April 14, 2015, EPA received a letter from Baker Botts L.L.P. on behalf of Entergy Arkansas Inc. identifying an error in the modeled location of the Entergy Independence facility.[1] We confirmed that an error was made when the latitude and longitude for the facility were input into a spreadsheet to convert decimal degree coordinates into the Lambert Conformal Conic (LCC) coordinates required for the CALPUFF modeling. 34 degrees latitude was input instead of the correct value of 35 degrees latitude. This caused the modeled facility location to be approximately 110km further south than the correct location. The table below shows the location that was used in the previous CALPUFF modeling and the revised value. Additional modeling was completed using the corrected facility location. That modeling is described here.

Three versions of the conversion spreadsheet that were used are available in the docket for our proposed action[2]:

1) The original
2) The spreadsheet that was previously relied upon for the Independence facility location
3) The revised spreadsheet that corrects the error identified above

Table 1. Location of Entergy Independence

	Latitude	Longitude	LCC X-coordinate (km)	LCC Y-coordinate (km)
previous location	34.6733	-91.4083	510.8348	-572.7073
revised location	35.6733	-91.4083	504.0342	-462.3251

[1] April 13, 2015 letter from Mr. Bill Bumpers to Mr. Guy Donaldson, Chief, Air Planning Section, EPA Region 6, RE: Request for an Extension of the Public Comment Period on the Proposed Rule to Promulgate a Regional Haze and Interstate Visibility Transport Federal Implementation Plan for Arkansas, Docket No. EPA-R06-OAR-2015-0189

[2] See "AR020.0140-00 Additional documents - Lambert Conformal Conversion workbooks and location correction" available in the docket to this proposed rulemaking

Modeling Protocol

As with the previous modeling, we utilized the CALMET v5.53a output generating by Trinity Consultants and the current regulatory version of CALPUFF (v5.8.4). In POSTUTIL the MNITRATE =1 setting was used to repartition the total nitrate to reflect the competition between sulfate and nitrate for available ammonia and in a step referred to as —Nitrate Repartitioning. CALPOST was then used to calculate visibility using the modeled concentrations and the revised IMPROVE equation.

All additional modeling was conducted following the same modeling protocol utilized in the previous modeling for the Independence facility. Appendix C to the Technical Support Document[3] describes the modeling protocol, model inputs and emission rates modeled. The only change made was to change the location of the facility. Modeling was performed on a facility-wide basis for each control scenario, as outlined below[4].

Control Scenarios:

1. Baseline (BASE) – Emission rates for NOx and SO2 are from maximum actual 24-hr emissions during the 2001-2003 period.
2. Dry Scrubber (DFGD) - Emission rates for NOx are maximum actual 24-hr emissions during the 2001-2003 period. SO2 emissions are controlled to 0.06 lb/mmBTU.
3. Wet Scrubber (WFGD) – Emission rates for NOx are maximum actual 24-hr emissions during the 2001-2003 period. SO2 emissions are controlled to 0.04 lb/mmBTU.
4. Baseline 2 (BASE2) –Emission rates for SO2 are maximum actual 24-hr emissions during the 2001-2003 period. Emission rates for NOx are maximum actual 24-hr emissions during the 20011-2013 period.
5. LNB/SOFA (LNB) – Emission rates for NOx are at the LNB/SOFA controlled value of 0.15 lb/mmBTU. Emission rates for SO2 are maximum actual 24-hr emissions during the 2001-2003 period.
6. LNB/SOFA and DFGD (LNB_DFGD) - Emission rates for NOx are at the LNB/SOFA controlled value of 0.15 lb/mmBTU. SO2 emissions are controlled to 0.06 lb/mmBTU.
7. Dry Scrubber and Baseline 2 (BASE2_DFGD) - Emission rates for NOx are maximum actual 24-hr emissions during the 2011-2013 period. SO2 emissions are controlled to 0.06 lb/mmBTU

[3] See "AR020.0002-00 TSD for EPA's Proposed Action on the AR RH FIP" available in the docket to this proposed rulemaking

[4] Emission inputs for each scenario are included in Attachment A to Appendix C of the TSD.

Additional Modeling Results

Visibility Modeling of SO_2 Control Scenarios

Table 2 presents the maximum value of the 98th percentile of the daily maximum impact for the three modeled years (2001-2003) for the facility for the baseline and SO_2 control scenarios. SO_2 controls provide for improvements in visibility, lowering the impact the facility has on any single Class I area by 1.05 to 1.18 dv. There is little difference between the results of the WFGD and DFGD in the 98th percentile values. At the low sulfur emission levels of these controls, nitrates are responsible for the majority of visibility impairment so little benefit is seen in decreasing SO_2 emissions from the DFGD rate of 0.06 to the WFGD rate of 0.04 lb/mmBTU.

Table 2. Entergy Independence: EPA Modeled Maximum 98th Percentile Visibility Impacts (Δdv) of SO_2 Controls (Facility-wide)

Class I Area	Distance (km)	Visibility Impact			Visibility Improvement Over Baseline		Incremental Visibility Improvement of Wet FGD vs. Dry FGD
		BASE	Dry FGD	Wet FGD	Dry FGD	Wet FGD	
Caney Creek	277	2.512	1.416	1.399	1.096	1.113	0.017
Upper Buffalo	180	2.264	1.086	1.068	1.178	1.196	0.018
Hercules-Glades	173	1.868	0.812	0.797	1.056	1.071	0.015
Mingo	174	1.859	0.814	0.795	1.045	1.064	0.019
Total	-	*8.503*	*4.128*	*4.059*	*4.375*	*4.444*	0.069

Table 3 presents the maximum value of the 98th percentile of the daily impact for the three modeled years for the baseline and DFGD control scenarios utilizing more recent emissions data for the NOx emissions (BASE2). These results utilize the maximum 24-hr NOx emissions from the 2011-2013 period, which are lower than emission rates from the 2001-2003 baseline. Modeled visibility benefits from the use of DFGD are similar to those modeled with the 2001-2003 baseline NOx emissions values shown in Table 2. We note that had we modeled a more recent baseline for SO_2 emissions, the baseline visibility impact would be greater and the visibility benefits modeled from the control scenarios would be greater.

Table 3. Entergy Independence: EPA Modeled Maximum 98th Percentile Visibility Impacts (Δdv) of SO_2 Controls (Facility-wide) with BASE2

Class I Area	Distance (km)	Visibility Impact		Visibility Improvement Over Baseline
		BASE2[5]	Dry FGD[6]	
Caney Creek	277	2.028	1.045	0.983
Upper Buffalo	180	2.003	0.819	1.184
Hercules-Glades	173	1.734	0.595	1.139
Mingo	174	1.761	0.608	1.153
Total	-	7.526	3.067	4.459

Visibility Modeling of NOx Control Scenarios

Table 4 presents the maximum value of the 98th percentile of the daily maximum impact for the three modeled years (2001-2003) for the facility for the baseline and NOx control scenarios. The baseline results utilize the maximum 24-hr NOx emissions from the 2011-2013 period, which are lower than emission rates from the 2001-2003 baseline. LNB/SOFA provides for improvements in visibility on any single Class I area ranging from 0.15 to 0.46 dv.

[5] Baseline NOx emissions were updated to the maximum 24-hr emissions from 2011-2013 for the evaluation of the anticipated benefit from NOx controls.

[6] Baseline NOx emissions were updated to the maximum 24-hr emissions from 2011-2013 for the evaluation of the anticipated benefit from NOx controls.

Table 4. Entergy Independence: EPA Modeled Maximum 98th Percentile Visibility Impacts (Δdv) of NOx Controls (Facility-wide) with BASE2

Class I Area	Distance (km)	Visibility Impact		Visibility Improvement of LNB/SOFA Over Baseline
		BASE2[7]	LNB/SOFA	
Caney Creek	277	2.028	1.569	0.459
Upper Buffalo	180	2.003	1.805	0.198
Hercules-Glades	173	1.734	1.561	0.173
Mingo	174	1.761	1.613	0.148
Total	-	*7.526*	*6.548*	*0.978*

Visibility Modeling of NOx and SO2 Control Scenarios

Table 5 presents the maximum value of the 98th percentile of the daily maximum impact for the three modeled years (2001-2003) for the facility for the two different baselines modeled and a control scenario with both LNB/SOFA and DFGD. The "BASE" results utilize the maximum 24-hr SO_2 and NOx emissions from the 2001-2003 period.

The "BASE2" results utilize the maximum 24-hr NOx emissions from the 2011-2013 period, which are lower than emission rates from the 2001-2003 baseline. We note that had we modeled a more recent baseline for SO_2 emissions, the baseline visibility impacts would be greater and the visibility benefits modeled from the control scenarios would also be greater. Modeling of both LNB/SOFA and DFGD shows visibility benefits ranging from 1.40 to 1.52 dv at each Class I area when compared to BASE2, compared to visibility benefits ranging from 1.05 to 1.18 dv for only DFGD when compared to BASE and 0.98 to 1.18 dv for only DFGD when compared to BASE2.

[7] Baseline NOx emissions were updated to the maximum 24-hr emissions from 2011-2013 for the evaluation of the anticipated benefit from NOx controls.

Table 5. Entergy Independence: EPA Modeled Maximum 98th Percentile Visibility Impacts (Δdv) of NOx and SO_2 Controls (Facility-wide) with BASE and BASE2

Class I Area	Distance (km)	Visibility Impact			Visibility Improvement of LNB/SOFA and DFGD Over BASE	Visibility Improvement of LNB/SOFA and DFGD Over BASE2
		BASE	BASE2[8]	LNB/SOFA and DFGD		
Caney Creek	277	2.512	2.028	0.56	1.952	1.468
Upper Buffalo	180	2.264	2.003	0.482	1.782	1.521
Hercules-Glades	173	1.868	1.734	0.331	1.537	1.403
Mingo	174	1.859	1.761	0.338	1.521	1.423
Total	-	8.503	7.526	1.711	6.792	5.815

Comparison of Previous and Additional Visibility Modeling

A summary of the previous modeling results is available in Appendix C to the TSD. Visibility modeling results for this additional modeling can be found as Attachment B to this document. As shown in Table 6 below, modeled visibility benefits from SO2 control (dry flue gas desulfurization) are the same or larger in the additional modeling. The largest difference is an increase in modeled visibility benefit from control of 0.29 dv (to a total of visibility improvement of 1.178 dv) at Upper Buffalo. The largest modeled benefit from NOx controls is at Caney Creek and is approximately the same in the additional modeling. Modeled visibility benefits from NOx control at the three other Class I areas are slightly smaller in the additional modeling. The change in location of the modeled facility resulted in different transport patterns from the facility to the Class I areas and the modeled 98th percentile visibility impacts to be more driven by sulfate impacts. Therefore, benefits from reductions in NOx emissions on the 98th percentile days are slightly reduced.

Previous modeling of the control scenario including both LNB/SOFA and DFGD showed visibility benefits ranging from 1.18 to 1.48 dv at each Class I area when compared to BASE2. The additional modeling shows larger visibility benefits ranging from 1.40 to 1.52 dv at each Class I area for the combination of LNB/SOFA and DFGD compared to BASE2

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[8] Baseline NOx emissions were updated to the maximum 24-hr emissions from 2011-2013 for the evaluation of the anticipated benefit from NOx controls.

Table 6. Summary of Previous and Additional Regional Haze Modeling for the Entergy Independence Plant.

Class I area	Visibility improvement over baseline (BASE) (deciviews)		Visibility improvement over baseline (BASE2)[9] (deciviews)	
	Dry flue gas desulfurization (previous)	Dry flue gas desulfurization (additional)	Low NOx burner/Separated overfire air (previous)	Low NOx burner benefit/Separated overfire air (additional)
Caney Creek	0.938	1.096	0.461	0.459
Upper Buffalo	0.888	1.178	0.248	0.198
Hercules-Glades	1.056	1.056	0.264	0.173
Mingo	0.871	1.045	0.213	0.148

[9] Baseline NOx emissions were updated to the maximum 24-hr emissions from 2011-2013 for the evaluation of the anticipated benefit from NOx controls.

Attachment A. Entergy Independence Additional Visibility Modeling CALPUFF files

Due to the file size of the CALPUFF modeling files, they are not available from the electronic docket. These files are available upon request. Please email your request to: Michael Feldman (feldman.michael@epa.gov) or call 214-665-7200

Attachment B. Entergy Independence Additional Visibility Modeling Results

BASE

Class I Area	98th Percentile for Each Year			3 year average	3 year maximum
	2001	2002	2003		
Caney Creek	2.512	1.727	2.073	2.104	2.512
Upper Buffalo	1.737	2.148	2.264	2.050	2.264
Hercules-Glades	1.736	1.864	1.868	1.823	1.868
Mingo	1.859	1.357	1.386	1.534	1.859
Sum	***7.844***	***7.096***	***7.591***	***7.510***	***7.844***

DFGD

Class I Area	98th Percentile for Each Year			3 year average	3 year maximum
	2001	2002	2003		
Caney Creek	1.416	0.858	1.115	1.130	1.416
Upper Buffalo	0.857	1.084	1.086	1.009	1.086
Hercules-Glades	0.747	0.809	0.812	0.789	0.812
Mingo	0.752	0.662	0.814	0.743	0.814
Sum	***3.772***	***3.413***	***3.827***	***3.671***	***3.827***

WFGD

Class I Area	98th Percentile for Each Year			3 year average	3 year maximum
	2001	2002	2003		
Caney Creek	1.399	0.827	1.086	1.104	1.399
Upper Buffalo	0.832	1.064	1.068	0.988	1.068
Hercules-Glades	0.724	0.797	0.795	0.772	0.797
Mingo	0.733	0.643	0.795	0.724	0.795
Sum	***3.688***	***3.331***	***3.744***	***3.588***	***3.744***

BASE2

Class I Area	98th Percentile for Each Year			3 year average	3 year maximum
	2001	2002	2003		
Caney Creek	2.028	1.559	1.805	1.797	2.028
Upper Buffalo	1.655	2.003	1.958	1.872	2.003
Hercules-Glades	1.679	1.634	1.734	1.682	1.734
Mingo	1.761	1.261	1.201	1.408	1.761
Sum	***7.123***	***6.457***	***6.698***	***6.759***	***7.123***

LNB/SOFA

Class I Area	98th Percentile for Each Year			3 year average	3 year maximum
	2001	2002	2003		
Caney Creek	1.569	1.335	1.443	1.449	1.569
Upper Buffalo	1.505	1.805	1.741	1.684	1.805
Hercules-Glades	1.433	1.421	1.561	1.472	1.561
Mingo	1.613	1.137	1.124	1.291	1.613
Sum	***6.120***	***5.698***	***5.869***	***5.896***	***6.120***

DFGD_BASE2

Class I Area	98th Percentile for Each Year			3 year average	3 year maximum
	2001	2002	2003		
Caney Creek	1.045	0.649	0.823	0.839	1.045
Upper Buffalo	0.653	0.819	0.815	0.762	0.819
Hercules-Glades	0.552	0.595	0.594	0.580	0.595
Mingo	0.573	0.484	0.608	0.555	0.608
Sum	***2.823***	***2.547***	***2.840***	***2.737***	***2.840***

LNB/SOFA_DFGD

Class I Area	98th Percentile for Each Year			3 year average	3 year maximum
	2001	2002	2003		
Caney Creek	0.560	0.368	0.452	0.460	0.560
Upper Buffalo	0.354	0.482	0.455	0.430	0.482
Hercules-Glades	0.331	0.329	0.318	0.326	0.331
Mingo	0.326	0.251	0.338	0.305	0.338
Sum	***1.571***	***1.430***	***1.563***	***1.521***	***1.571***